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indane Can Help Control California Flatheaded Borer in Jeffrey Pine

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ABSTRACT: A 1.5 percent formulation of lindane in diesel oil proved to be an effective insecticide against all stages of the insect, *Melanophila californica*. Particularly high mortality occurred in the early-instar larvae under the bark. The chemical had a residual life of more than 9 months and was not affected by rain or snow on the sprayed logs.

RETRIEVAL TERMS: *Melanophila californica* Van Dyke; *Pinus jeffreyi*; forest insects; hexachlorocyclohexane ($C_6H_6Cl_6$); control (chemical); pesticide; insecticide; California flatheaded borer; lindane.

OXFORD: 414.1+145.719.66.

The California flatheaded borer (*Melanophila californica* Van Dyke) kills pine trees in southern California, where periodically it causes serious losses of Jeffrey pine (*Pinus jeffreyi* Grev. & Balf.). Lyon[1] recommended ethylene dibromide (EDB) spray as a direct control measure. A lindane spray would be more desirable since it is cheaper and easier to use than EDB. And if the insecticide could be used year-round, efforts to control the California flatheaded borer could be made more effective. In the U.S. Forest Service's California Region, a 1.5 percent lindane spray is recommended for suppression of all pine-killing bark beetles. An earlier test had shown that lindane was effective year-round against the western pine beetle (*Dendroctonus brevicomis*).[2]

In winter of 1964-1965, we field-tested a 1.5 percent lindane spray to determine its toxicity and residual life when applied on the California flatheaded borer in Jeffrey pine. The insecticide was sprayed on infested logs monthly from November through April. The treated and check bolts were caged in May, emerging insects were collected daily, and the number of dead insects were counted. The test strongly demonstrated the effectiveness of lindane in diesel oil against the California flatheaded borer.

METHODS

AREA AND TREATMENT

The test area was located on the San Jacinto District of the San Bernardino National Forest, where a severe outbreak of the California flatheaded borer was devastating Jeffrey pine.

All trees to be treated were selected for the test before the first treatment. Only trees with heavy borer populations were selected for test trees, beginning in November and continuing through April. Four trees were felled each month. Each tree was limbed, and the heaviest infested portion of the bole was bucked and blocked up off the ground to allow for complete spray coverage. This piece was marked into three 4-foot logs; the two outer logs were sprayed, and the center log was left as an untreated check. Strips of polyethylene were wrapped around each check log at the time of spray application to prevent contamination (fig. 1).

We used a 20 percent lindane concentrate (without emulsifier), containing

[1] Lyon, R.L. *California flatheaded borer.* U. S. Forest Serv. Forest Pest Leafl. 24, 7 pp., illus. 1958.

[2] Lyon, R.L., and Swain, K.M. *Field tests of lindane against overwintering broods of the western pine beetle.* (MS. in preparation.)

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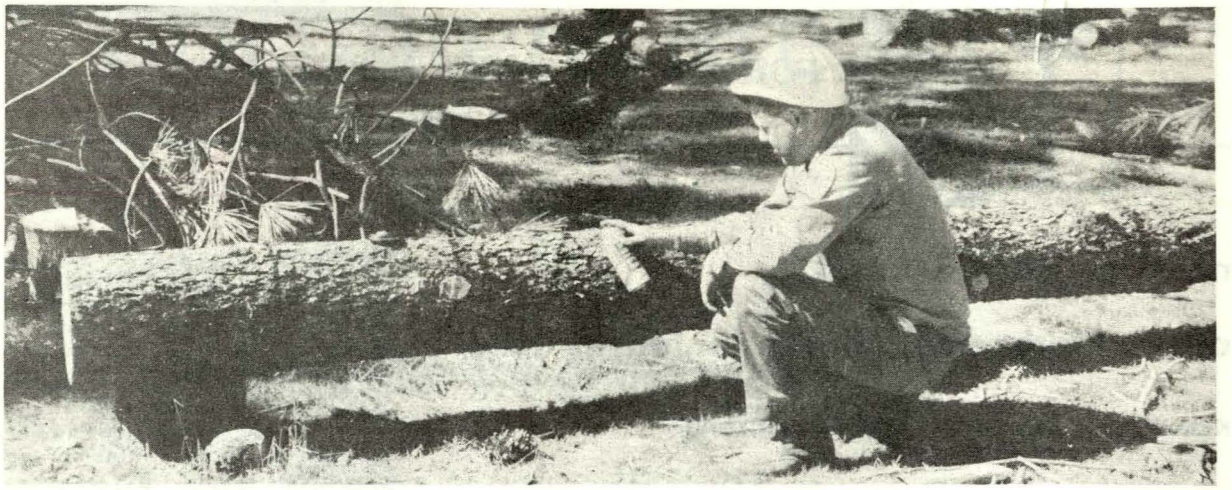

Figure 1.--*Test logs were marked before spraying. They were blocked up to allow for complete spray coverage.*

1.7 pounds of lindane per gallon of solvent. A 1.5 percent formulated spray was prepared by mixing 1 part of the concentrate to 15 parts diesel oil. Each batch of spray was tested by a commercial laboratory for percent of lindane. All the batches of the formulated spray tested satisfactorily. A Hudson pressure-type garden sprayer was used to apply the insecticide. This sprayer is similar to the one used in operational projects. We sprayed at the rate of 1 gallon per 17-inch-d.b.h. tree or until the bark appeared glistening wet, taking care to see that all sides of the section were completely sprayed. All test logs remained in place until early May.

During the 6-month period, 15 inches of precipitation fell on the November test logs, and 5.5 inches fell on the April test logs (fig. 2). Some of it was in the form of snow.

REARING

The first week in May, 28-inch bolts were cut from the middle of each 4-foot log and labeled. These bolts were trucked to the Pacific Southwest Station's Hat Creek Forest Insect Laboratory, Shasta County, Calif., for rearing. The check and sprayed bolts were separated by a tarpaulin during transit. The bolts --42 treated and 24 checks--were reared outdoors in individual cardboard

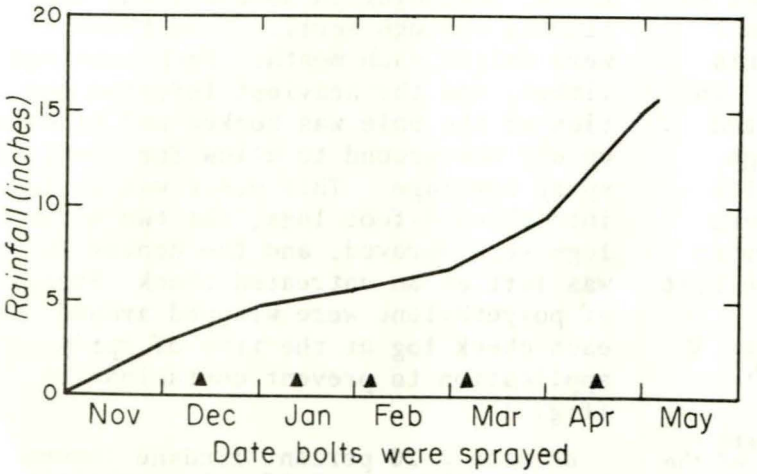

Figure 2.--*Accumulative rainfall during winter 1964-1965, San Jacinto District, San Bernardino National Forest, California, and dates when bolts were sprayed.*

Figure 3.--*Cardboard boxes used to cage logs infested with the California flatheaded borer. Screw-type jars were fastened at the bottom of each cage. Screened slits provided ventilation. A thermograph with probe was used to check cage temperatures.*

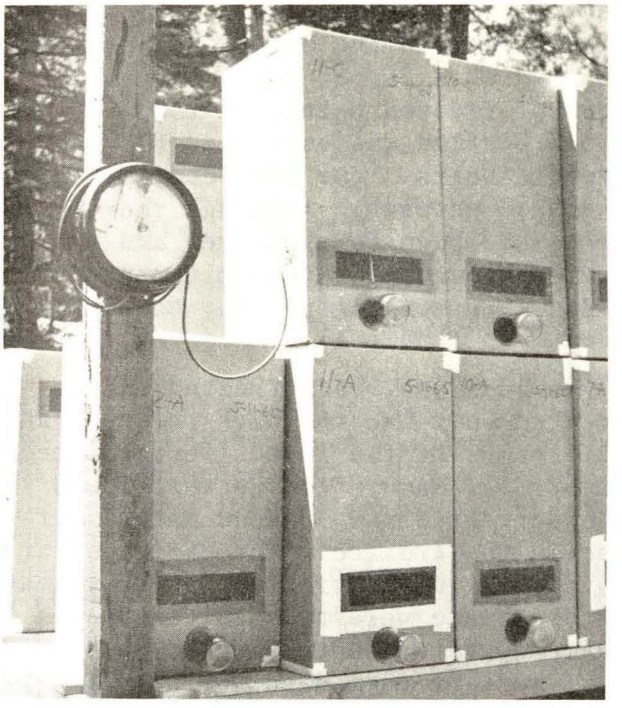

Figure 4.--*Adult California flatheaded borers on fresh Jeffrey pine foliage were confined in 1-gallon cartons.*

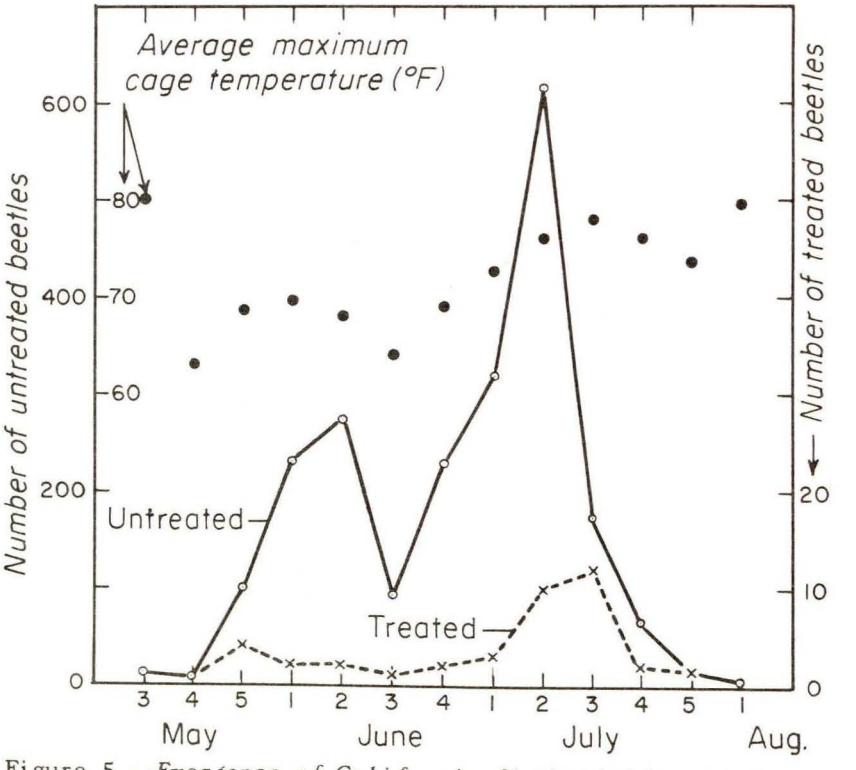

Figure 5.--*Emergence of California flatheaded borers from treated and untreated Jeffrey pine logs, by average maximum cage temperatures and week of emergence.*

cages with ventilation screens and collecting jars (fig. 3). Thermograph probes were maintained in the most exposed cages to check daily temperatures. When cage temperatures exceeded 90°F. in mid-June a sunshade made from snow fencing was placed over the tops of the cages.

The daily collection, made each afternoon, from each cage was put in an individual gallon ice cream carton containing Jeffrey pine foliage. The foliage was watered by a test tube attached to the bottom of the carton. The adults were held on the foliage for 72 hours to allow feeding (fig. 4). These cartons were checked daily to record mortality.

Moribund beetles were tallied as alive if they could still move after 72 hours. Beetles were considered dead when no movement was elicited by probing; the elytra of dead beetles did not lock in the open position, which is a characteristic of lindane poisoning in bark beetles.

Larval mortality was checked in late August after adult emergence ceased, by peeling the bark from all of the logs and noting the dried remains of early-instar larvae and adults. Since the late-instar larvae enter the bark to pupate, mortality checks of this stage were made by radiographing 6-by 9-inch bark samples from one-fourth of the treated and untreated logs. Some bark samples were also dissected. The radiographic technique also provided a method of checking for winter holdover of prepupal larvae in the bark.

RESULTS

Emergence began on May 12 during the caging process; it coincided with warm weather and continued sporadically until early August (fig. 5). Total emergence (table 1) was 2,120 beetles from 162 square feet of untreated bark and 41 beetles from 287 square feet of treated bark (13 and 0.14 beetles per square foot, respectively).

In the treated, 17 of the 41 beetles were alive after 72 hours but were in a moribund condition. Since only a few beetles emerged from the treated, we found that most insects died under the bark in the early larval stages. Therefore, an assumed population was calculated from the number of beetles per square foot in the untreated bolts and applied as a direct ratio per square foot of treated bolts. A total of 3,623 beetles was estimated for the treated bolts. The corrected mortality was 99.5 percent. Although the treated bolts had been sprayed over a 6-month period, there was no significant difference in mortality owing to month of treatment (table 1).

In addition, each treated and untreated bolt had the bark removed, and all stages of the insect were counted. Eight dead mature larvae were found in the untreated and 30 dead mature larvae in the treated. The early-instar mortality in the treated was very heavy --the larvae were too desiccated to make accurate counts, but it was obvious that most of them died during this stage.

A radiographic sampling technique used to determine larval mortality in the bark appeared to be highly accurate. The interpreter could easily distinguish between live and dead larvae.[3] Radiographs of 6 square feet of treated bark disclosed 4.1 dead and 0.17 live larvae per square foot. A smaller sample of untreated bark (2 square feet) revealed no larval mortality and 1.6 live larvae per square foot. These larvae held over winter in diapause and became adults the following June. There was no emergence from the treated bark samples.

DISCUSSION

Most of the mortality counts in this test were calculated from an assumed population related to that contained in

[3] Wickman, Boyd E. *Use of radiography to detect mortality of California flatheaded borers in pine bark.* J. Econ. Entomol. 59 (4):1028-1030, illus. 1966.

Table 1.--*Emergence and mortality of California flatheaded borer, Shasta County, California, 1964-1965*

Month of treatment	Untreated		Treated				Corrected mortality
	Total emergence	Dead after 72 hrs.	Emergence		Dead after 72 hrs.		
			Total[1]	Actual	Total[1]	Actual	
	Number						*Percent*
Nov.	609	149	578	2	577	1	99.7
Dec.	427	113	845	14	840	9	99.2
Jan.	277	48	580	2	579	1	99.8
Feb.	423	87	865	11	861	7	99.4
Mar.	242	44	476	8	472	4	99.3
Apr.	142	36	279	4	277	2	99.1
Total	2,120	477	3,623	41	3,606	24	99.5

[1]Initial population calculated from a direct ratio of beetles per square foot in the untreated bolts to square foot in the treated bolts

untreated logs. This type of evaluation was necessary because there was such a high under-the-bark mortality that very few insects completed their development to adults. Those that developed and emerged contacted the spray in the bark tissue while emerging and were dead or moribund after 72 hours.

Lyon[4] has found evidence of mortality caused by contamination in some of his studies using cardboard cages for holding lindane-sprayed logs. If such contamination did occur in this present test, it probably had little effect on the results. There are two reasons for this assumption: First, most of the mortality occurred in the early-instar larvae shortly after spraying, and the logs were left uncaged in the forest under natural conditions for as long as 6 months when this mortality occurred. Second, if the adults which emerged were affected by cage contamination, there was such a small number involved that removing them from the mortality calculations would not significantly alter the results.

The lindane-diesel spray, with its deep bark penetration, appears to have a long residual life--the sprayed logs produced only 40 beetles and all were dead or moribund. Adult mortality was higher in November-sprayed logs than in logs sprayed in April, although the November-treated logs were subjected to three times the amount of precipitation. Because lindane kills more insects and costs less than ethylene dibromide, we recommend it for the control of the California flatheaded borer.

[4]Lyon, Robert L. *Chemical control of bark beetles. 1963 studies.* 1964. (Unpublished report on file Pacific SW. Forest & Range Exp. Sta., U.S. Forest Serv., Berkeley, Calif.)

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